Resource Choices and the Environment

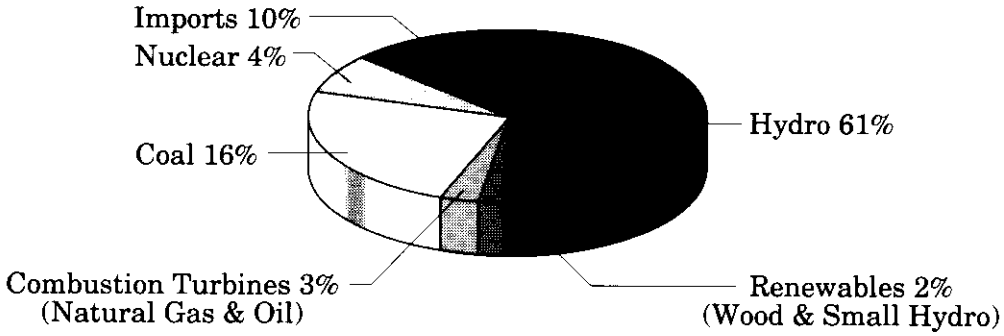
CONCEPT: Air, water, steam, and combustion gases can be used to spin turbines. These propellants are powered by various sources of energy. Each combination of energy source and propellant is a resource choice. Resource choices have important environmental considerations that affect their physical design and their desirability.

DIRECTIONS: The students have seen how water, air, and steam can be used to power turbines, spinning magnets to make electricity. In this lesson students are asked to consider the environmental consequences of resource choices.

Ask the students to recall the environmental consequences of dams. What environmental effects can they think of relating to wind power?

Now consider steam as the propellant. We have to use some source of energy to heat water to make steam. Have students list as many sources as they can that can be used to heat water.

Northwest Resources



Total Resources = 20,600 Average Annual Megawatts

Oil, coal, natural gas, nuclear fission, solar, wood, and geothermal are all important energy sources that need to be listed. Indicate which are widely used at this time in the Northwest (see the Northwest Resources' chart). As a math exercise, have the students calculate how many megawatts of each resource is used in the Northwest from the information given on the chart. Students discuss how each fuel is burned, collected, or tapped to produce steam. Methane from rotting carbon-based materials (garbage) might not make the student list.

Every fuel must be evaluated for its impacts, e.g., global warming, greenhouse effect, ozone depletion, air pollution, and nuclear waste products. Have students illustrate how these fuels boil the water into steam (their diagrams may show boilers that look something like teapots. Some types of nuclear plants are similar to that idea. Most boilers consist of many vertically oriented pipes lining the walls of a combustion chamber. Steam rises to the tops and is collected to be sent to the turbine. See Appendix C.)

Students may also discuss ways of mitigating the environmental effects of the resources. They can redesign their models from the last lesson showing the improvements (boilers, solar collectors, fuel containment or ignition chambers) learned from this activity. They may also show how their design minimizes environmental consequences. Students can refer to Appendix C for descriptions and illustrations of full scale power plants.

Student designs should include the following elements:

Fuel Type, Environmental Impacts, Boiler (if needed), Turbine, and Generator (spinning magnet and a nearby coil).

LAB: Coal is a fossil fuel. Hand out a piece of coal to each student. Have the students examine it and describe it in their notes. Students should answer these questions about coal in their notes: "How can this be plant material?" "How long did it take to turn into coal?" "How does it burn?"

Students crush a piece of coal into dust. Will dust burn better than the lump? (Yes, because there is more surface area for faster oxidation.) How do we dispose of the leftovers from burning coal, particularly given its widespread use? Direct the students to clean up the crushed coal and coal dust from their tables and off their hands. At each classroom disposal site, have the following "Classroom Environmental Quality" forms ready for students.

Sinks. Students need to protect the water from contamination. If they are going to wash the dust down the sink or wash their hands, they must estimate what kinds of damage coal can produce in water systems, record those estimates, and suggest ways to minimize the consequences. Students do not need to know the consequences, but must address them in an "educated guess" or hypothesis fashion. They might consider: chemicals toxic to fish or insect life, changes in the pH (acidity) of the water, particulate matter that could interfere with animal life cycles, and contamination of drinking water.

Garbage Cans. Students should consider the effects of the waste coal entering the solid waste disposal system. Possible consequences include: contamination of ground water from the coal ash burial site; problems arising before the contamination gets to the burial site; and possible chemical interaction with other substances. Students need to record some way to deal with the problems before they can use the garbage can.

Air. Using the air to "dust off" their hands or blow the dust off the table should also be recorded on the Classroom Environmental Quality form. The potential for damage to lungs, eyes, or skin could be discussed. Local and global air contamination could also be considered.

Doing Nothing. Will the students just leave the coal dust on their hands, wipe it on their clothes, or leave it on the desks for somebody else to deal with? Can students name current local and global examples of this "no-action" method of dealing with contaminants or wastes?

This exercise is not meant to discourage the use of coal as a fuel. Every fuel could be analyzed in the same way. What makes coal a good choice for producing energy (the US. has an enormous supply of coal, enough for hundreds of years to come)? Is it possible to com-

pensate for all the environmental effects of coal plants? How much are we willing to pay to keep our air, water, and land free from pollutants?

Our purpose is to demonstrate the need to identify effects of our actions before we take those actions. The quantity of contaminants used in this exercise is too small to be of consequence in the classroom, but the enormous quantities of coal used in electrical generation plants represent significant environmental engineering challenges. A typical coal plant may consume one train car of coal each hour.

Classroom Environmental Quality Form **Before you take an action, you must consider the consequences.**
ACTION
POSSIBLE CONSEQUENCES
POSSIBLE REMEDIES